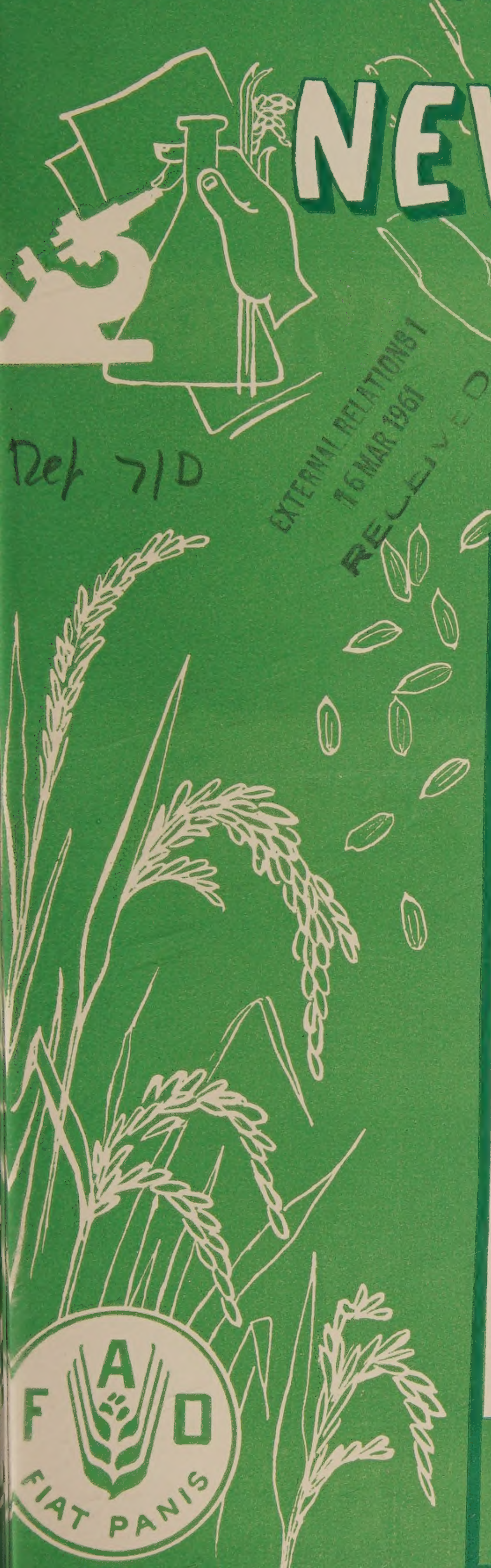
INTERNATIONAL RICE COMMISSION

NEWSLETTER



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RATOON CROPPING OF SHORT-SEASON RICE VARIETIES IN TEXAS[1]

N.S. Evatt and H.M. Beachell[2]

Introduction

Commercial rice varieties grown in Texas may be classified according to the number of days they require from seeding to reach maturity. Early maturing varieties require 109 to 132 days; midseason, 132 to 150 days; and late, 150 to 180 days (**4**). The growth period is influenced by seeding date, with a longer period required when seeded early in the season. In Texas, rice is usually seeded from early March to late June, but most of the crop is seeded in April and May. Rice breeders in Texas are in the process of developing very early maturing varieties that mature in 100 to 105 days. This report presents grain yield comparisons between short season experimental varieties and commercial varieties, and gives results obtained from different cultural practices used in ratoon crop production.

Ratoon cropping appears to be a practical means of increasing rice yields. This practice is gradually increasing in Texas by using existing early maturing varieties. An estimated 10,000 to 20,000 acres were used for double cropping during 1959. Since some ratoon crop acre yields of 1,500 to 2,000 pounds of paddy rice have been reported, a further increase in the practice can be expected in the future. The Texas growing season negates the production of two crops of rice on the same land from separate seedings within a single year.

Description of Texas Rice Area

Rice is grown extensively throughout the Coastal Prairie of Texas. The Coastal Prairie (**3**) is a physiographic region of over 7½ million acres extending inland 50 to 100 miles from the Gulf of Mexico and lying between the Louisiana border and the San Antonio River. The annual rainfall varies from about 55 inches on the eastern side to less than 35 inches at the western extremity. The rainfall is usually fairly well distributed throughout the year, with no consistent dry or wet periods. The soils range in texture from clays to sandy loams. Soils with restricted internal drainage and suitable for rice are common in the area. General soil fertility is rather low since much of the area is deficient in nitrogen and phosphorus and, to a lesser extent, in potassium.

The average number of days between the last occurence of 32°F. temperatures in the spring and the first occurence in the fall is over 260 days for most of the area.

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1 *Contribution from the Texas Agricultural Experiment Station, the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, and the Texas Rice Improvement Association.*

2 *Associate agronomist, Texas Agricultural Experiment Station, Rice–Pasture Experiment Station, Beaumont, Texas, and research agronomist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beaumont, Texas.*

General Comparisons of Short-Season Varieties

One of the major objectives of the rice breeding program at the Rice-Pasture Experiment Station, Beaumont, Texas, has been to develop suitable long-grain varieties that will mature in 100 to 105 days. Several selections are now in the advanced testing stage. Varieties of this type offer the possibility of greatly increased yields by ratoon cropping. Reduced total production costs should be possible from increased acre yields of this magnitude. Varieties of later maturity are not as well adapted to ratoon cropping because of the danger from low temperature injury to the ratoon crop.

Regardless of maturity, a suitable variety must meet vigorous specifications. It must be high yielding, resistant to important diseases, adapted to combine harvesting and artificial drying, and possess those processing and cooking characteristics required by consumers. When maturity time is reduced to approximately 100 days, other characteristics increase in magnitude. Cultural operations and environmental conditions are apt to affect such varieties to a greater extent. Therefore, very early maturing varieties should possess inherent capacities for rapid germination and vigorous seedling development.

Grain yield data from two promising 100-day selections are compared with the three important commercial varieties, Century Patna 231, Bluebonnet 50, and Nato, in Table 1. Over 80 percent of the rice grown in Texas in 1959 was of these three varieties.

TABLE 1

Small-plot tests showing yields per acre of paddy rice for five rice varieties.

Variety	Field Plots		Plots seeded in—		Average
	1958	1959	May, 1959	June, 1959	
	(Lbs.)	(Lbs.)	(Lbs.)	(Lbs.)	(Lbs.)
Experimental 100-day:					
C.I. 9434	4435	3846	3449	3239	3742
C.I. 9433	3788	3512	3305	3343	3487
Commercial:					
Century Patna 231	3810	3881	3538	3158	3597
Bluebonnet 50	3587	3588	2925	3211	3378
Nato	3494	3811	3914	3157	3594

The results obtained indicate that under favorable conditions very early maturing varieties have the inherent capacity to produce yields comparable with leading commercial varieties.

Research work at the Beaumont Station indicates that time of fertilizer application is extremely important in very early maturing varieties (2). For maximum returns the entire amount of fertilizer must be applied during the first one-third of the growth cycle. Applications after this period may result in yield decreases. There were no consistent variety-fertilizer differential yield responses between early maturing varieties and later maturing varieties when fertilizers were applied at comparable stages of growth.

In 1956, extensive small plot tests were initiated on ratoon rice production at the Rice-Pasture Experiment Station (**1**). It appeared that nitrogeneous fertilizers, applied at the correct time, appreciably increased yields. Clipping heights of the first crop seemed to influence maturity of the ratoon crop. The lower clipping height (4 inches) delayed the maturity but showed a more uniform growth and maturity. Regular combine clipping height, where approximately one-half of the straw is removed, has since been found preferable over lesser heights.

It has been established that additional nitrogen is required for the ratoon crop. A rate of approximately two-thirds of the original nitrogen rate should be applied immediately following the first harvest. Where adequate rates of phosphorus and potassium have been applied to the first crop, no additions of these elements are necessary for the ratoon crop. A light, flush-type irrigation is applied for fertilizer placement. When new tillers from the basal or crown portion of the plant are 4 to 6 inches in height, a shallow flood is maintained until harvest.

A major limiting factor to successful ratoon crop production using varieties such as Century Patna 231 that mature in 120 days is the low temperature hazard. This applies both to the original and to the ratoon crop. Such varieties must be seeded during the latter part of March when temperatures may be relatively low since the first crop must be harvested before the middle of August. When Century Patna 231 is harvested after mid-August, considerable risk is involved in ratoon culture since the second crop requires from 75 to 90 days to mature. Low temperatures in late October or early November may drastically reduce yields of the ratoon crop. Varieties maturing as late as Bluebonnet 50 (132 to 150 days) seldom produce satisfactory ratoon crops.

In 1959, the very early maturing variety, C.I. 9433, was grown in a ratoon cropping experiment in which various nitrogen fertilizer treatments were applied to the stubble immediately following the harvest of the first crop. C.I. 9433 was seeded April 23, the first crop harvested August 12, and the ratoon crop harvested October 11. The main plot was treated uniformly and produced a first crop yield of 3670 pounds of paddy rice per acre. Various fertilizer treatments were then applied and ratoon crop yields obtained for each treatment. These are presented in Table 2.

TABLE 2

Ratoon crop yields of C.I. 9433 in pounds per acre of paddy rice with different fertilizer treatments.

Fertilizer treatment on ratoon crop—N-P_2O_5-K_2O	Acre Yield
(Lbs.)	(Lbs.)
0–0–0	684
0–40–0	872
60–0–0	1394
60–40–0	1384
120–0–0	1916
120–40–0	1859

Ratoon crops of C.I. 9433 and similar varieties mature in approximately 60 days, while later maturing varieties require 75 or more days. Therefore, the reduction in the time required for maturity of both the first and second crop practically eliminates the risks associated with low temperatures at seeding time for the first crop and during the ripening period for the ratoon crop.

Summary

Information presented indicates that, under favorable growing conditions, varieties requiring 100 to 105 days from seeding to maturity will produce yields comparable with those of varieties requiring longer growing periods. It is postulated that the use of such very early maturing varieties will eliminate much of the risk involved in ratoon culture by reducing the necessity of early seeding and by providing a more favorable growth period for the ratoon crop.

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THE RESPONSE OF SHORT-STRAWED RICE VARIETIES TO VARYING LEVELS OF NITROGEN FERTILIZATION[1]

N.S. Evatt, T.H. Johnson and H.M. Beachell[2]

Results presented herein were obtained from cooperative "high nitrogen fertilization" experiments grown at the Rice Branch Experiment Station, Stuttgart, Arkansas in 1958 and at the Rice-Pasture Experiment Station, Beaumont, Texas in 1957 and 1958. The purpose of the experiments was to determine the response of relatively short sturdy strawed rice varieties to moderate and high levels of nitrogen fertilization.

Varieties and Treatments

The same 9 varieties were used at both locations. They were divided into 3 maturity groups, using 3 varieties in each maturity group. The number of days from seeding to maturity of varieties within each maturity group was approximately 135 days for the mid-season group; 125 days for the early group and 105 for the very early group. Bluebonnet 50, Century Patna 231 and Nato, all important commercial varieties, were included in the experiments.

In 1958, the nitrogen rates used at both locations were 0, 40, 80, 120, 160 and 200 pounds N per acre. In 1957 the Texas experiment included the same treatments, except the highest treatment of 320pounds rather than 200 pounds N per acre.

The time of applying nitrogen varied somewhat at the 2 locations. At both locations, fertilizer was applied at time of seeding and at the early tillering and late tillering stages of development. However, in the Arkansas experiment, the highest nitrogen treatments were divided so that 40 pounds of N were applied in the late boot stage; in the Texas experiment in 1957, 80 pounds of the highest rate of N applied in the pre-boot stage.

The time of application of nitrogen was adjusted for the 3 maturity groups so that all varieties received nitrogen at approximately the same stages of plant development and on dry soil. However, rainfall prevented strict adherence to this schedule in several instances. The actual dates of nitrogen applications and corresponding stages of plant development are reported in Tables 1, 2 and 3. All nitrogen applications were made on relatively dry soil except for the early boot stage applications made in the Arkansas experiments.

Sources of nitrogen were from urea in the Arkansas experiment and from ammonium sulphate in the Texas experiments.

Before seeding in the Arkansas experiment, 100 pounds of P_2O_5 and 120 pounds K_2O per acre were worked into the soil. The Texas experimental area received a

1 *Contribution from the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, the Texas Agricultural Experiment Station, the Arkansas Agricultural Experiment Station and the Texas Rice Improvement Association.*

2 *Associate Agronomist, Rice-Pasture Experiment Station, Beaumont, Texas, and Research Agronomists, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, Stuttgart, Arkansas and Beaumont, Texas, respectively.*

surface application of 60 pounds P_2O_5 and 40 pounds K_2O per acre immediately following seeding of rice. In both instances the P_2O_5 and K_2O treatments used were considered adequate for maximum yields of rice at each location, based on previous experiments. Sources of phosphorous and potash were 46 percent superphosphate and potassium chloride, respectively.

Soil Types

The Arkansas experiment was on Crowley silt loam soil that had been cropped to rice for approximately 50 years. During the first 20 years of this period, a rice crop was grown each year. During the next 20 years rice was grown about every other year, and every third year during the recent decade.

TABLE 1

Nitrogen treatments showing rates and stage of growth when applied to rice in variety-fertilizer experiment, Stuttgart, Arkansas, 1958

Total Nitrogen Applied (per acre)	Time of nitrogen application: 1 day after seeding (all groups)	23 days after seeding (all groups) (early tillering)[2]	62, 49 & 49[1] days after seeding (late tillering)[3]	102, 85 & 75[1] days after seeding (late boot)
lbs.	lbs.	lbs.	lbs.	lbs.
0	0	0	0	0
40	40	0	0	0
80	40	40	0	0
120	40	40	40	0
160	80	0	40	40
200	80	0	80	40

1 *Mid-season, early, and very early variety groups, respectively.*
2 *Time of first flood.*
3 *Time of second flood.*

TABLE 2

Nitrogen treatments showing rates and stage of growth when applied to rice in variety-fertilizer experiment, Beaumont, Texas, 1957.

Total Nitrogen Applied (per acre)	Time of nitrogen application — Number pounds nitrogen per acre applied: Immediately after seeding (all groups)	34, 30 & 30[1] days after seeding (early tillering)	51, 54, & 41[1] days after seeding (late tillering)	65, 64 & 54[1] days after seeding (pre-boot stage)
lbs.	lbs.	lbs.	lbs.	lbs.
0	0	0	0	0
40	40	0	0	0
80	80	0	0	0
120	80	40	0	0
160	80	80	0	0
320	80	80	80	80

1 *Mid-season, early, and very early maturing varieties, respectively.*

TABLE 3

Nitrogen treatments showing rates and stage of growth when applied to rice in variety-fertilizer experiment, Beaumont, Texas, 1958.

Total Nitrogen Applied (per acre)	At seeding (all groups)	32, 32 & 32[1] days after seeding (early tillering stage)	56, 54 & 54[1] days after seeding (late tillering stage)
lbs.	lbs.	lbs.	lbs.
0	0	0	0
40	40	0	0
80	80	0	0
120	80	40	0
160	120	40	0
200	120	40	40

1 *Mid-season, early and very early maturing varieties, respectively.*

The Texas experiments were on Beaumont clay soil that had been used for rice 50 or more years. This land was cropped to rice about every other year until 1946, and every third year since.

Crowley silt loams are usually slightly acid to neutral, are friable and have granular structure 6 to 24 inches thick. Beaumont clays are heavy dense clays that are slowly permeable and medium acid.

Experimental Methods

In the Arkansas experiment, varieties were seeded in blocks of 32 rows 14 feet in length, with the rows spaced 12 inches apart. Variety served as a main plot and the 6 fertilizer treatments were the subplots. Treatments were randomized within each variety and varieties were randomized within each of the 4 replications. Each maturity group was sown in a separate area to permit proper water management. The fertilizer applied at time of seeding was placed in the soil about 1 inch deep and about 1 inch to the side of each row. Subsequent applications were applied on the soil surface in the 4 "middles" of each plot, equidistant between the adjacent rows to give the proper rate. Yields were obtained from the 3 center rows of each plot. No precipitation fell from time of seeding to first irrigation (23 days). There was little apparent response from the nitrogen applied at seeding time. This indicates that some of the effectiveness of this application might have been lost. Prior to the "second flood" treatment, the test area of each maturity group was drained and the soil allowed to dry to the point of cracking. The scheduled treatments were then applied and plots flooded immediately. About 3 days prior to the "late boot" application the test area was drained and allowed to dry sufficiently to become firm enough to permit topdressing. A flood was then held until a few days prior to harvest.

The test area was given an early post-emergence treatment of Chloro-IPC about 10 days after seeding to control

grassy weeds. The space between the rows was hoed as necessary to remove any grassy weeds which remained in the middles. The few weeds remaining in the rows did not interfere with normal plant development.

The Texas experiments were conducted in much the same manner each year. A randomized split plot design was used with variety constituting the main plot. The varieties were randomized within maturity groups and fertilizer treatments were randomized within each variety. Maturity groups were randomized within replications so that each replication of each maturity group could be irrigated and drained independently. The fertilizer subplot size was 4×15 feet or six rows, spaced 8 inches apart and 15 feet long. The 2 center rows of each 15-foot plot were harvested for yield determinations. The rice was seeded in dry seedbeds. All blocks were irrigated immediately following seeding to promote germination of rice. The fertilizer applied at time of seeding followed seeding but preceded irrigation.

In 1957 experiment rice was sown May 15 and in 1958 experiment, May 1. Plots were flood irrigated throughout most of the growing period of the rice, commencing 30 to 35 days after seeding or when the rice was in the early tillering stage. The plots were drained and soil aerated a short period when the rice was 54 to 65 days old. The plots were free of weeds and grass that might affect yield of grain or growth of the rice.

Effect of Nitrogen on Maturity

In the Arkansas experiment the different treatments appeared to have little effect on the number of days from seeding to maturity for varieties in the very early group. In the other 2 groups the rice in plots receiving 80, 120 and 160 pounds per acre of nitrogen matured slightly earlier than the rice receiving the other treatments. These results confirm earlier observations in Arkansas that early and adequate, but not excessive, applications of nitrogen tend to speed up maturity of rice. The average period from seeding to maturity of all varieties was one day longer when no nitrogen was applied than when the excessive rate of 200 pounds was applied.

In the Texas experiments nitrogen applications up to 120 pounds N per acre hastened time of maturity by 1 to 3 days over O nitrogen treatments in the midseason and early groups but delayed maturity at higher rates. In the very early group, the 40 and 80 pound treatments hastened maturity by 1 to 2 days and higher rates delayed maturity by 2 to 5 days.

Effect of Nitrogen on Plant Height

With minor exceptions, all varieties in the Arkansas experiment were progressively taller as the total amount of N was increased from 0 up to 120 pounds. Because of the difference in timing and the possible loss of part of the "at seeding" application of treatment 5 (160 lb. N), all varieties had shorter straw from this treatment than from either the 120 or the 200 pound treatment. Varieties in the midseason and early groups averaged slightly taller in the 200-pound treatment than from the 120-pound treatment, whereas the reverse was true for the very early group. In each of the 3 maturity groups the variety with the

shortest straw (least plant height) produced the highest average grain yield.

The rice in the Texas experiments, without exception, showed a rapid linear height increase from the 0 nitrogen to the highest treatment. The average height of all varieties was 37.8 and 36.8 inches, respectively, for the 0 nitrogen plots in 1957 and 1958. The highest N rate resulted in heights of 53.6 and 46.2 inches, respectively. The 2-year average heights of all varieties for the 80, 120 and 160 pound treatments were 41, 45.5 and 47.5 inches, respectively.

Effect of N on Lodging

In the Arkansas experiment no lodging occurred in any of the varieties in the midseason group even where 200 pounds of nitrogen was applied. As indicated earlier, the total effective nitrogen from this rate may have been somewhat less than the 200 pounds actually used. With the exception of the 160 pound treatment, each of the early varieties showed progressively higher amounts of lodging as the rate of nitrogen fertilization was increased. However, the early varieties averaged only 14 percent lodging in the 160 pound treatment and in the 40 pound treatment.

In the 1957 Texas experiment severe lodging occurred in most of the 160 and 320 pound N treatments and only minor lodging in lower rates. There were no apparent varietal differences. In 1958 erratic lodging occurred in some of the 160 and 200 pound N treatments but no consistent varietal differences were observed.

Effect of N on Grain Yields

The average grain yields of each of the 9 varieties grown in the 3 experiments are shown in Tables 4, 5 and 6. In all three experiments the midseason and early variety groups showed increases in grain yields as nitrogen was increased from 0 to 120 pounds. Variety increases were statistically significant in 48 of the 54 cases. In the very early group, grain yields increased as nitrogen was increased to 80 pounds and variety increases were significant in all but 4 cases. At rates above 80 pounds the very early maturing varieties showed few statistically significant yield increases. In Arkansas the average grain yields of varieties receiving the 160-pound treatment averaged about 60 percent higher than the 40-pound treatment. This indicates the importance of proper timing of nitrogen applications to obtain high grain yields with reduced plant height and a minimum of lodging. In the 1958 Arkansas and Texas experiments, all variety groups showed higher average yields at the 200 pound N rates than at 120 N rates, but in only 2 cases were the increases statistically significant. The 1958 average acre yields for the 120, 160 and 200 pound treatments were 4701, 4721 and 4898 pounds respectively. In the 1957 Beaumont experiment the 320 pound N treatments averaged lower than the 120 pound treatments due to more sterility, lodging, and rodent damage in the 320 N plots. The 160 and 120 pound treatments averaged about the same in 1957 at Beaumont. In the Arkansas experiment, the very early varieties yielded considerably lower than varieties in the other 2 maturity groups. In the Texas experiments, yields of the very early varieties compared favorably with other maturity groups in treatments up to 80 pounds of N. At the 120 and 160 pound rates they usually yielded much lower than midseason and early varieties.

TABLE 4

Yields in pounds of rough rice per acre from variety-fertilizer tests grown at Stuttgart, Arkansas in 1958

Maturity group and Variety	Pounds per acre of nitrogen 0	40	80	120	160	200	Average Acre Yield
							lbs.
	Yield of rough rice – pounds per acre[1]						
Midseason group:							
Bluebonnet 50	2732	3137	4291	5556	5203	5561	4413
B49-4601-5	2526	2983	4898	5533	4901	5531	4395
B502A2-98-1	3204	3942	5388	5987	5707	6202	5072
Average	2821	3354	4859	5692	5270	5765	
Early group:							
C.I. 9187	2556	3340	4922	6058	5821	6937	4939
Nato	2666	3316	4792	5833	5368	6006	4664
CP 231	2494	3396	4726	6085	5397	6306	4734
Average	2572	3351	4813	5992	5529	6416	
Very early group:							
C.I. 9382	2131	2886	3541	4161	4226	4053	3500
C.I. 9205	2250	3190	4475	4710	4959	4848	4072
C.I. 9386	2075	2421	3470	4056	4235	4081	3390
Average	2152	2832	3829	4309	4473	4327	

1 *LSD* .05	*Nitrogen*	*Variety*	*Variety × nitrogen*
Midseason group	*315*	*336*	*NS*
Early group	*216*	*NS*	*NS*
Very early group	*496*	*NS*	*NS*

TABLE 5

Yields in pounds of rough rice per acre from variety-fertilizer tests grown at Beaumont, Texas in 1957

Maturity group and Variety	Pounds per acre of nitrogen 0	40	80	120	160	320	Average Acre Yield
							lbs.
	Yield of rough rice–pounds per acre[1]						
Midseason group:							
Bluebonnet 50	2310	3425	3298	4413	4959	4905	3885
B49-4601-5	3148	3802	4677	5038	4839	3822	4222
B502A2-98-1	2394	3334	4105	5028	4729	3574	3860
Average	2618	3520	4027	4827	4842	4100	

Early group:							
C.I. 9187	2568	3159	4413	5006	5855	4371	4227
Nato	2696	3742	3742	3836	3392	1912	3221
CP 231	2589	3075	3791	4564	4512	1848	3396
Average	2618	3326	3982	4468	4586	2710	
Very early group:							
C.I. 9382	2336	3311	4092	3541	3204	2129	3102
C.I. 9205	2411	3438	4303	4445	4163	3125	3648
C.I. 9386	1670	2812	4120	4285	4355	3110	3392
Average	3128	3188	4172	4090	3907	2788	

1 *LSD .05*	*Nitrogen*	*Variety*	*Variety × Nitrogen*
Midseason group	*727*	*NS*	*NS*
Early group	*382*	*316*	*661*
Very early group	*386*	*271*	*667*

TABLE 6

Yields in pounds of rough rice per acre from variety-fertilizer tests grown at Beaumont, Texas in 1958

Maturity group and Variety	Pounds per acre of nitrogen 0	40	80	120	160	200	Average Acre Yield
							lbs.
	Yield of rough rice—pounds per acre[1]						
Midseason group:							
Bluebonnet 50	2094	2718	3396	4378	4671	4464	3680
B49-4601-5	1553	2478	2944	4721	5056	5024	3629
B502A2-98-1	1935	2203	3004	4385	4758	4427	3452
Average	1861	2466	3115	4615	4828	4638	
Early group:							
C.I. 9187	2518	2577	3366	4601	4887	5231	3863
Nato	1982	2492	2961	3779	3954	4010	3196
CP 231	3199	3045	3565	4530	5182	5136	4110
Average	2566	2705	3297	4303	4674	4793	
Very early group:							
C.I. 9382	1597	2621	2789	2282	2268	2796	2392
C.I. 9205	2738	2848	3529	4180	4606	3775	3612
C.I. 9386	1785	2354	2658	3419	3786	3712	2952
Average	2040	2607	2992	3294	3554	3428	

1 *LSD .05*	*Nitrogen*	*Variety*	*Variety × Nitrogen*
Midseason group	*392*	*NS*	*NS*
Early group	*271*	*277*	*470*
Very early group	*399*	*373*	*690*

In the Arkansas experiment, statistically significant varietal differences were obtained in only the midseason group. The Texas experiments showed statistically significant varietal differences both years for the early and very early groups but no significant differences for the midseason group. There were no significant variety × nitrogen interactions recorded in Arkansas but such interactions were significant each year in Texas in the early and very early maturity groups.

The short-strawed variety, B502A2-98-1, yielded significantly higher than other varieties in the Arkansas experiment. This variety is a pure line selection made from a cross between Bluebonnet and Century Patna 231. It has shorter straw than either parent. In Texas the average heights, based on all treatments for both years, were 40.7, 44.8 and 46.8 inches for the selection, Century Patna 231 and Bluebonnet 50, respectively. In spite of shorter height at Beaumont, the selection lodged and failed to show higher yielding ability at the higher nitrogen rates.

The highest grain yield for any variety-treatment combination was 6937 pounds per acre produced by C.I. 9187 at the 200 pound N treatment in the Arkansas experiment. There were no significant yield differences in this group at Arkansas but C.I. 9187 outyielded the other 2 varieties in the 160 and 200 pound nitrogen treatments by over 400 pounds per acre. In the Texas experiment C.I. 9187 produced higher 2-year average yields than other early varieties in the 4 highest nitrogen treatments and produced the highest grain yield for any variety-treatment combination each year. C.I. 9187 averaged 40 inches in height at Beaumont as compared with heights of 44 and 44.7 inches for Nato and Century Patna 231, respectively.

In the very early group, C.I. 9205 produced higher grain yields than other very early varieties in all Arkansas treatments and in all Texas treatments except the 160 pound rate in 1957. In Texas C.I. 9205 averaged 39 inches tall while C.I. 9382 and C.I. 9386 averaged 42.3 and 42.9 inches, respectively.

Discussion

The varieties used were those considered most likely to show yield increases at high nitrogen rates. Short, sturdy-strawed varieties were chosen along with the shorter strawed commercial types. Known high yielding japonica varieties were not used because they lodge severely in the Southern States under high nitrogen conditions. The only true japonica variety used in the experiments described was C.I. 9205. It showed some evidence of possessing higher yielding ability than other varieties in the very early group. Unfortunately, C.I. 9205 was highly susceptible to blast at the higher N rates. Had it not been for blast, the yields of C.I. 9205 probably would have been comparable to midseason and early maturing varieties.

Wide-spread testing of varieties for response to high N will almost certainly give valuable leads to the rice breeder in developing high yielding varieties that will withstand high N rates without severe lodging. Short, sturdy-strawed varieties with reduced leaf area are being selected from hybrid populations and from foreign introductions for further studies of this nature. Several such varieties are now ready for testing.

RICE IN THE SUDAN

R.L.M. Ghose[1] and Yacoub El Sayegh[2]

Introduction

The rice crop has been only recently introduced in the Sudan. Its culture was started some 10 years ago when the Government interested itself in the introduction and the establishment of the crop in the agricultural economy of the country with a view 1) to having more diversified and varied cropping, 2) to give South Sudan a cash-cum-food crop and to increase its food production and 3) to make the country self-sufficient in rice and to stop rice imports, which at present reach 5,000 to 6,000 tons a year and cost the country about quarter million pounds sterling. Work was therefore undertaken to find out the possibilities of growing rice in the Sudan, to determine suitable varieties, suitable localities and the best cultural technique for the production of the crop. The work was first started at Malakal in the Upper Nile Province and later extended to centres situated further south in the Bahr El Ghazal Province. The rice areas of the Sudan lie below 10° North latitude, and at present the crop comprises 1,000 *feddans* (1 *feddan* = 1.038 acres) in Bahr El Ghazal (at Wau, Tonj and centres in Aweil district) and 250 *feddans* in Upper Nile Province at Malakal. Land eminently suitable for rice is available in abundance in Sudan and the area under the crop is being gradually expanded.

Crop growing conditions

In Bahr El Ghazal the crop is grown in the *toiches*, which are vast stretches of grassy lowlands or riverain plains lying idle and uncultivated. The *toiches* are periodically enriched by silt as they are subject to inundation by the over-flow from the rivers during the rainy season. The frequency of flooding of the *toich* varies, depending on the situation of the *toich* Inundation of the land may be annual feature as in Aweil district or it may occur at irregular intervals as in Wau and Tonj. During a period of 17 years beginning with 1943 the Aweil *toich* was flooded every year while the Wau and Tonj *toiches* were flooded only 8 years. The time, period and duration of the flood are very variable; they vary from year to year and from place to place. Flooding of the *toich* may start as early as end of July or as late as beginning of October; however, it usually occurs from about the middle of August to the beginning of September. The flood may start subsiding as early as end of September to as late as middle of November. The duration of the flood varying from a few days to about 3½ months. The duration is longest in Aweil varying for 2 to 3½ months.

The rainfall in Bahr El Ghazal is well apread from April to October with most of the rain being received during the period May to September. During the period November to March there may be occasional light showers. The mean annual rainfall for 22 years (1938-1959) at the stations Wau, Tonj and Aweil is given along with the highest and the lowest rainfall recorded at these stations during this period.

1 *FAO Rice Production Expert, Wau (Sudan)*

2 *Senior Inspector of Agriculture, Wau (Sudan)*

Annual rainfall record (1938-1959)

Station	Mean (mms)	Highest (mms)	Lowest (mms)
Wau	1166.5	1488.1	895.4
Tonj	1003.9	1455.2	754.2
Aweil	933.2	1265.8	544.7

During the wettest part of the year there are approximately 17-18 rainy days with daily rainfall ranging from a few millimetres to about 80 mms or so. The rainfall is usually received in short spells of sharp showers.

It may be mentioned here that till the *toich* is inundated by the over-flow from the rivers, water is hardly ever found standing in the rice fields and though the soil surface appears dry, the water table, however, is very close to the surface during the rainy season. It may also be mentioned that in contrast to the monsoon regions, where for most part of the growing period of the crop the skies are cloudy and overcast, the crop in Bahr El Ghazal grows for most of the time under clear and sunny skies. During the crop season the maximum temperature in Bahr El Ghazal varies from 31°C to 35°C and the minimum temperature varies from about 20°C to 30°C. The soil of the *toiches* varies from fairly stiff clay to more sandy clay and loam and is reported to be slightly acid (Polderman 1959).

The crop in Upper Nile Province in Malakal is grown under pump irrigation, the annual rainfall is less than in Bahr El Ghazal, the mean for the 22 year period (1938-1959) being 807.9 mms, highest being 1176.1 mms and the lowest being 569.1 mms. The rainfall, as in Bahr El Ghazal, is received mainly in the months of May to October. The soil in Malakal is heavy cracking clay (black cotton soil, strongly alkaline in reaction with pH of over eight (Polderman 1959).

Agronomic and cultural practices

Rice cultivation in Bahr El Ghazal and Upper Nile Province is mechanized in almost all its aspects. Preparatory cultivation is started with deep ploughing of the land as early as possible in the season. For this purpose the land is tractor ploughed once with a G.L. 71 four disc plough or a Ransome dragoon four disc plough. Three to four weeks after first ploughing the land is given a discing with either a medium disc like Massey Harris 909 having 13 discs or with a wide level disc like Massey Harris 26 having 30 discs, a second discing is given to the land immediately before sowing.

The crop sown with the setting in of rains from about the middle of May to about the middle of June, however, the sowing may be as early as the beginning of May or as late as the first week of July. The crop is directly seeded with a Massey Harris 306 double coultered seed dril in rows 15 cms apart at the rate of 40 kgs. per feddan.

In Bahr El Ghazal the crop is not fertilized as the *toiches* get enriched by the silt deposits from the flooding of the land, however, in Malakal the crop is fertilized with ammonium sulphate applied at the rate of 40-50 kgs. per feddan. The fertilizer is applied broadcast after the first weeding.

Weeding is done by manual labour using hand implements. For control of weeds two weedings are usually given, however, sometime a third weeding is found necessary. The first weeding, which is usually given about 5-6 weeks after

the establishment of the crop, is heavy while the second weeding is mostly light.

Depending on the variety the main crop at Bahr El Ghazal and Malakal is ready for harvest by about the end of November to the middle of December. In Malakal the crop is harvested by a combine, for this purpose a Massey Harris 780 self-propelled combine is used. In Bahr El Ghazal the crop is harvested and threshed by manual labour. In harvesting the crop the stalk is cut close to the earhead by sickles and grain threshed out by beating the earheads with sticks. Manual harvesting and threshing of the crop in Bahr El Ghazal is only a temporary phase and it is planned to mechanize these operations as early as possible.

Varieties

At present the varieties grown on large or small scale are mostly introductions from Burma and Thailand. The principal varieties at Malakal are No. 1422 (*Schwe Pu* C34-1 of Burma) an No. 1423 (*Nagasein Phinme* C14-8 of Burma). Both of these are non-lodging, long duration varieties, flowering about the middle of November and on the average yield 700-800 kgs. of paddy per *feddan*.

In Bahr El Ghazal the main variety grown is No. 1369 (*Pin Kaeo* of Thailand). It is somewhat earlier than 1422 or 1423, flowering about the end of October and giving a yield of about 800 kgs. of paddy per *feddan*. With this variety yield as high as 1248 kgs. (just about 1¼ tons) of paddy per *feddan* was obtained from an area of 70 *feddans* in 1958-59.

In Bahr El Ghazal for maturing of long duration varieties like 1369 flooding of the field is required, unless the rainfall in the month of October is plentiful. However, varieties of shorter duration, even of 135-140 days duration, can be grown satisfactorily as purely as rain-fed crop. An unfertilized, rainfed crop of variety 1346 (variety Century of Louisiana U.S.A.) 120-.25 days in duration, grown in an area of 24 *feddans* yielded over 600 kgs. of paddy per *feddan*.

In Bahr El Ghazal, therefore, a purely rainfed crop as well as a crop requiring flood water in addition to the rainfall to mature can be grown. However, *toiches* suitable for these two types of crop have to be carefully determined.

Pests and diseases

Except for sporadic and casual occurrence the rice crop in the Sudan is at present singularly free of insect pests and diseases. Among insect pests some instances of stem borer and gall fly (*Pachydiplosis oryzae*) have been observed, however geese, cranes and other birds in large numbers attack the ripening crop particularly in Aweil district. With regard to diseases, stray cases of blast (*Piricularia oryzae*) and helminthosporise (*Helminthosporium oryzae*) are found to occur.

Prospect

Rice is a promising crop in the Sudan and has a bright future in the agricultural economy of the country. It can be very successfully grown in South Sudan and the yield obtained compares very favourably with those obtained in the tropical rice countries of the world. Vast stretches of eminently suitable land, like the *toiches* of Bahr El Ghazal, are available. These are lying idle and uncultivated at present and the rice production poten-

tiality of the country and the scope for expansion of the crop are great.

The cost of production per *feddan* is reported by Polderman (1959) to be £13.100 in Bahr El Ghazal and £18.100 at Malakal. These figures, however, do not include writing-off for depreciation of equipment, and with the inclusion of depreciation, Polderman considers the cost would be about £16.700 and £25.600 for Bahr El Ghazal and Malakal respectively.

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A NOTE ON SOME IRRIGATION PRACTICES IN TAIWAN

Peter Kung[1]

The following contains information on irrigation in Taiwan, obtained and assembled during a field trip to Central and South Taiwan. This trip was made by the author from April 25 to May 26, 1960, and covered twelve districts.

As new and large irrigation projects are being carried out in many countries in Asia and the Far East, it may be helpful to study experiences in other countries having similar natural conditions, agricultural aspects and traditions. Taiwan is one of those countries where at least a part of the problem connected with irrigation has been solved. A knowledge of the irrigation practices in this Island may be of use to those countries which are faced with similar problems.

Administration and Construction of Irrigation Works and Channels

Taiwan is divided into 26 irrigation districts and each of these is managed by a Hydraulic Association organized by the farmers themselves. The function of the Association is to operate and maintain all the canals, drains and reservoirs within their respective districts and to manage the allotment of water through regional and sectional offices. Above the Hydraulic Associations is the Provincial Water Conservancy Bureau (PWCB), the highest administrative agent on water conservation in the Island. Responsibility for the construction of irrigation works serving more than 500 hectares (1235 acres) lies with the Bureau, whereas the local Hydraulic Associations are in charge of the smaller projects.

Proposals for new irrigation projects are usually initiated by a Hydraulic Association and submitted to the Bureau for scrutiny. Once it is approved, the Bureau shares 50 % of the total cost in the form of a grant while the Association itself bears the balance of the expenditure. The Land Bank and the Cooperative Bank may extend loans to the Associations for the same purpose.

The Hydraulic Associations take full responsibility as to design and construction of field channels. Necessary funds are granted by the Association, to be repaid by the members (or water users) from the collection of special membership fees. These fees are collected in addition to annual membership fees or water charges, only when a new construction work is undertaken while at least $\frac{2}{3}$ of the member votes are required before any action is taken. Construction is done entirely by contractors. Voluntary labor of members is recruited only for subsequent repair and maintenance of the channels. Owners whose land is taken up for this purpose are compensated immediately.

Plot channels are designed by the Association but constructed by the farmers themselves. No compensation is given for occupied land in that case.

Irrigation Practices for Dry Crops during the Winter

Irrigation projects in Taiwan are mainly designed for the two crops of rice which cover the period from March to

1 *FAO Expert in Irrigation Agronomy, East Pakistan.*

November. Irrigation is supplied for dry crops only during the winter, "dry crop" meaning here a crop requiring less water.

In Northern Taiwan, where humid weather prevails during the winter, a total of 73.5 mm. (about 3 inches) of water is given to all crops with sweet potato as the major and radish, cauliflower and mustard as minor crops. The irrigation period is from early November to early February.

In Central Taiwan water resources are plentiful. Irrigation is therefore unlimited for winter crops such as wheat, tobacco, flax, rape-seed, maize, sweet potatoes, vegetables and green manure crops. No water is supplied, however, during the period from 20 November to 20 December when the annual clean-up and repairs of canals and structures is undertaken.

The weather is extremely dry during the winter and water resources are scant in Southern Taiwan. Irrigation there is given upon request to winter crops only once, i.e. in February to a depth of 75 mm. (about 3 inches). Sugarcane, the main crop in this region, receives a special treatment: three irrigations are given during each of the months of November, December and February, with a total depth of 270 mm. (about 10.5 inches).

Public Watermen System for Irrigation Operations

The Public Watermen System was initiated and adopted some thirty years ago by the Chia-Nam Hydraulic Association, the largest in Taiwan. The purpose of this system is to avoid any misuse and waste of water through a strict control of fields and irrigation by experienced personnel under an overall plan. The men are employed and paid by the Association on a contract basis for doing all the irrigation routine work for the growers during the crop season. Only by these means a total of 50,000 hectares (123,500 acres) of paddy fields can be irrigated with a limited supply of water. All Public Watermen are selected by regional officers of the Association with endorsement by the Chief of the respective smaller irrigation unit. Each unit comprises 50 hectares of land. The chief of the unit is elected by the growers within the unit. Two watermen form a team taking care of the irrigation routine of each unit. The candidate should be of good health, have a broad knowledge of irrigation and cultivation, sense of fair-play in business and be within the age limit of 20 to 60. He should not be a native of the same village where the unit is located and should have no land within that unit. Each of the men works 12 hours a day and the two meet each day at 6:00 A.M. and 6:00 P.M. for changing over duty. The following facilities are supplied by the Association which are essential for work on the field.

a. Straw hat — with mark "Public Watermen"

b. Arm band — with his own name

c. Alarm clock on wooden case — to assure the exact time for each irrigation

d. Flash light — necessary for night duty

e. Mark flag — to be planted on the fields during operation

f. Spade or hoe — necessary for opening and closing the earth tubes

g. Irrigation plan — showing name (or number) of small irrigation unit, name (or number) of the field and plot channels, number of field, acreage, name and address of owner, kind and variety of crop, water requirement of field, frequency and duration of irrigation, date and time of start and finish of irrigation (hour and minute)

h. Irrigation map — showing location and acreage of each field

i. Metal container — for storing plans and maps

j. Thatch shelter — for rest.

During rainy days, the watermen attend to weeding or clearing of field channels. They are also responsible for preventing illegal irrigation by farmers.

At the present, 1,003 teams with 2,006 public watermen are engaged by the Chia-Nam Hydraulic Association. They work in harmony with the staff of the Association and the growers. The staff members operate the water control gates of the field channels in this region during the irrigation period whereas the growers do all field operations except irrigation for their own fields. All these activities last for 137 days from June 1st to October 15th. Many advantages are derived from this system, such as saving labor for the growers, effective use of water, avoiding disputes between users, etc.

The same system of water control is adopted by associations in some regions where frequent droughts are prevalent.

Crop Improvement through Irrigation in the Saline Region

There are about 38,000 hectares (or 81,860 acres) of cultivated lands in the coastal region in the Chia-Nam Hydraulic District where soils are highly saline. Crop improvement through drainage and irrigation has been very successful. Besides ordinary irrigation and drainages systems, salt water drains are installed, 35 meter (115 ft.) apart. Adequate water is given to a crop of rice in the dry season while dry crops are grown during the rainy months only. One shallow plowing and two deep plowings (6 inches) are recommended before and after each crop season. This helps to stop capillary upsurge of the salt solution from subsoil to surface under dry conditions. After sowing of the dry crop, rice straw, to an amount of 4,500-5,000 lb/acre, is used to cover the whole field during the entire crop season. The soil temperature is kept down by this measure and capillary flow of the salt solution is greatly reduced. Attention is paid to compost and green manures as well as to chemical fertilizers in the saline area. According to experience, barley ranks first as a saline resistant crop, wheat ranks next followed by sweet potatoes and beans, in that order. Amongst the vegetables, garlic and onion grow well under saline conditions. Normal harvests are obtained after four to five years of applying the abovementioned measures.

IMPROVEMENT OF FARMING PRACTICE WITH SPECIAL REFERENCE TO FLEXIBLE RICE CULTURE METHOD

Kaio Komoda[1]

Introduction

The general farming practice in Japan is dependent upon the cropping system of rice, as rice is the most important staple food of the Japanese. Rice production is mostly concentrated on irrigated lowland with only a small part of it in upland rice. Both rice and wheat crops are grown in one year on many fields in the areas south of latitude 38°N. Rice is transplanted in June and harvested in late October or early November. Wheat is sown in November and harvested in June. Only one crop of rice is grown over 1.8 million hectares where poor drainage and soil conditions are not favourable for a second crop of wheat or barley. Rice is also produced in more northern areas beyond 38°N but the growing season is too short for double cropping with wheat or barley.

Rice thus occupies the land during the entire summer period regardless of the fact that the total heat energy available for a crop of rice varies from north to south. Under the traditional system of the above land use pattern technical improvement of rice culture has been primarily concerned with finding better varieties and cultural practices. Table 1 indicates the increase in yields obtained in the different geographical regions in Japan within the past 70 years.

TABLE 1

Increase in paddy rice yields within past 70 years[2]

	1881–85 average	1951–56 average	Per cent increase
	Kgs. per ha.	*Kgs. per ha.*	
Hokkaido	1,102	2,444	122
N.E. Part of Mainland	1,594	3,507	120
S.W. Part of Mainland	1,753	3,123	78
Shikoku Island	1,858	2,926	57
Kyushu Island	1,623	3,189	96
Total Japan average	1,767	3,259	84

It will be noticed that yield increases as well as actual yields have been much greater in the cooler northern area than in the warmer southern regions, notwithstanding the fact that the growing period in the transplanted fields is limited to hundred days in the northern region while in the south it extends to 140 days. This finding led to investigations as to the possibility of growing short season northern varieties in the south, to get higher productivity, instead of using long season southern varieties. Initially, however, it has not been possible

1 *Director, Oita Agricultural Experiment Station, Oita, Japan*

2 *According to R. Nakagawa (Mimeoprint of the National Kyushu Agricultural Experiment Station).*

to grow northern varieties in the south because many of the high yielding types from the north flower prematurely before optimum vegetative growth has been reached.

Discovery of Non-Seasonal Varieties

The author's experience in south eastern Asia showed him that there were exceptions to this general rule and that some northern varieties like Rikuu No. 132, Norin No. 1, Kameno—o etc. did not flower early under tropical conditions whereas most of the southern Japanese varieties did. After returning to the Kagawa Prefecture a number of northern varieties were tested and it was found that there were a few varieties which were non-seasonal. Such varieties were expected to mature within the same period in the south without abnormal early flowering. The growing of such varieties in the south would therefore release a portion of the warm period for other crops and there was also the possibility that the rice planting season could be extended from early April to the middle of August with corresponding harvests from late July to early November. There was also the possibility of raising two successive crops of rice without having to sacrifice the practice of growing winter cereals. Thus, rice culture in the warmer south western territory in Japan could become more flexible as far as the cropping season is concerned and the traditional fixed-season one rice crop system could completely be abandoned with benefit by the rice growers. In order to distinguish the old and new system and the rice planting period, the terms "early season rice growing" and "late season rice growing" are now used. While the entire season is sufficiently long at places south of 38°N latitude and irrigation water is not deficient throughout the period, it has definitely been proved that two consecutive rice crops can be raised in one year with a short interval for mechanized field preparation. With the progress of the author's activity with respect to the development of this new practice, the future of rice growing in terms of increased efficiency of land use, is far brighter than ever imagined before. With encouragement by the Government and enthusiastic participation of the farmers in following the practice all over the Kagawa Prefecture, the new practice has gained ground rapidly. When the early season rice growing campaign was first launched in the Kagawa Prefecture in 1953 the area under this system was only 36 hectares but at the end of 4 years, that is in 1957, the whole area in the south west devoted to this practice had increased to 70,978 hectares.

Changes in Farm Management

The fact that so many farm families are abandoning to a large degree the customary practice of rice growing and are now practising early season rice growing means that their farm management program is rapidly changing, as the new method allows modifications in the existing crop rotational system. The principle features of change in farm management are: (1) in the past the most serious handicap in rice growing in the territories of Kyushu island was the danger of exposing the rice crop at the time of heading (during September) to devastating typhoons, while there was also a possibility of nutritional decline of autumn

vigour (Akiochi); both of these result in considerable drops in yield. By harvesting the rice crop before the end of August this danger is avoided and it is no longer considered impossible to get 6,000 kgs. of brown rice per hectare by growing early season rice, (2) in the remaining warm period, left after harvesting of the early season rice crop, growing of autumn potatoes is gaining ground in the Kagawa, Hiroshima, Hyogo and Yamaguchi Prefectures, and yields are obtained from 10 to 30 metric tons per hectare, (3) in another type of rotation, forage crops like corn, oats, soya beans, etc. are grown, with yields of 37 to 56 metric tons per hectare, (4) dairy farming is promoted and in the Kagawa Prefecture alone, the number of milk cows has been increased from 300 to 10,000 during the period 1950 to 1956, (5) the growing of cash crops of green vegetables is another common usage of land after early season rice, not only Chinese cabbage (*Brassica pekinensis*), spinach, summer cabbage, etc., but also radish, carrot and turnips may be included in the cropping systems of the farms near to the cities, (6) owing to the fact that winter grains are not profitable a more economic substitute crop is now under consideration. Attempts to introduce autumn-sown sugar beet are now in progress. Sugar beet can be seeded readily in middle or late August and harvested by the middle of February next year to be followed either by early-sown rice and beets again afterwards or by a spring potato crop succeeded by the customary rice culture, and (7) above all, the entire system under the new scheme is contributing to further diversification and intensification of farm management.

Examples of New Land Use Program by the Introduction of Flexible Rice Culture Method in Warmer Areas of Japan

1) Progress in the adaptation of double cropping of rice in Kyushu: Development of the double cropping system of rice growing by combining early season and late season growing schedules in succession is comparatively slow in contrast with the progress of early season rice growing alone. Very early seeding is required on seed beds protected from cold by vinyl paper cover or in electrically heated nurseries. Seeds of the Tomoe-masari variety or of Norin No. 1 are sown on upland beds at a density of 140 to 230 grams per sq. m. during middle or late February after which the seedlings will be ready for transplantation in the field during early April to early May using a planting density of 24 hills (2 to 3 plants each) per square metre instead of 15 to 20 hills as in the customary practice. Without this close planting, normal yields cannot be expected within the short growing period of about three months in contrast to 4½ months in the customary method. The crop is ready to be harvested as early as middle or late July and this is followed by quick land preparation and levelling by use of motor tillers. Transplanting of the second crop should not be delayed beyond August 5. Late season varieties preferably Norin No. 22 and Fujisaka No. 5, are used for the second crop. The harvesting period of late season rice should not extend beyond the later part of October or early part of November. The increase in acreage devoted to double cropping rice culture in the Kyushu area is as below:

TABLE 2

Progress in the acreage of double cropping rice culture in Kyushu area with the number of participating farm families (1955 to 1957[1])

Name of Prefecture	1955		1956		1957	
	Number of farm families	Acreage	Number of farm families	Acreage	Number of farm families	Acreage
Fukuoka	6	1.2 ha	19	2.3 ha	405	76.2 ha
Saga	2	1.0	77	13.6	361	88.6
Nagasaki	3	0	12	2.0	184	18.4
Oita	0	0.2	27	2.2	464	61.9
Kumamoto	2	0.1	17	1.4	629	79.6
Miyazaki	8	0.9	12	1.9	303	40.8
Kagoshima	9	0.3	8	1.5	156	46.7
Total	25	3.7	172	24.5	2501	412.2

1 *The data are based upon the actual survey of field technicians of the Kyushu Electrical Power Corporation, Ltd.*

2) Record yields of early season rice growing: The recommended variety is Norin No. 17 and this variety is gaining popularity in recent years. The Ministry of Agriculture and Forestry conducts a nationwide contest amongst farmers for the highest yield per acre. Table 3 gives results of the 1956 contest for Kyushu block. It is seen that the last three winners are participants of early season growing and it is seen that the use of short season varieties compare very well with the yields of other late varieties which are harvested two months later.

TABLE 3

Record rice yields in the 1956 all-Japan contest

Name of Prefecture	Harvesting date	Name of variety	Planting density per sq.m.	Recorded yield in kg/ha	Yield in community level
Fukuoka	Nov. 6	Jukkoku	18	5683	3900
Saga	Oct. 24	Kimmaze	21	5727	2790
Nagasaki	Oct. 31	Norin No. 18	18	5134	2250
Oita	Oct. 26	Hozakaé	18	6162	2895
Kumamoto	Aug. 29	Norin No. 29	25	5970	3105
Miyazaki	Aug. 8	Norin No. 17	24	5548	2895
Kagoshima	Aug. 11	Norin No. 17	26	5308	2595

3) Increased efficiency in land use by dairy farmers by the introduction of early and late season rice growing systems: Tables 4a and 4b give a picture of the remarkable increase in land use efficiency in the Kagawa Prefecture. The first farm is situated in the middle of a lowland paddy area in which it is difficult to dry the field as the neighbouring farm lands are almost continuously irrigated. The second farm is situated in a hilly region where drying of the land is easy because of good drainage. The availability of land for rotation is therefore naturally higher in the latter and it can be seen that this farm operated three times as much land as is actually owned. In other words the family owns only 0.6 ha. of land but through introduction of the new cropping system they are able to grow crops from an area equivalent to 1.8 ha. Farm income, during the course of the study, may also have increased to a great extent, but actual figures are not available.

TABLE 4a

A diversified dairy farm family of lowland area in which land use efficiency showed a progress by the introduction of early and late season rice culture to a small extent.[1]

	1954	1955	1956
Farm land operated	1.11 ha	1.20	1.20
Number of milk cows	2.5	2.5	2.5
Acreage for rice			
1. Early season	0.08 ha	1.20 ha	0.20
2. Customary	0.98	0.92	0.90
3. Late season	0.05	0.08	0.10
For barley	0.81	0.56	0.50
For wheat	0.12	0.27	0.27
For sweet potatoes	0.02	0.03	–
For vegetables	0.11	0.37	0.58
For forage crops	0.13	0.18	0.29
For other uses	–	–	0.03
Total acreage of land in crop	2.31 ha	2.61 ha	2.87 ha
Availability of land in per cent	208 %	217 %	222 %

1. *The farm is located at Fuseishi-cho, Takamatsu-shi, Kagawa Prefecture.*

TABLE 4b

Another dairy farm family of upland area in which the land use efficiency showed much larger progress by the introduction of early and late season rice cultures to a larger extent.[1]

	1954	1955	1956
Farm land operated			
1. Paddy field	0.37 ha	0.37 ha	0.37 ha
2. Orchard	0.04	0.08	0.32
3. Dry farm	0.20	0.20	–
Total	0.61	0.65	0.69
Number of milk cows	1.0	1.5	2.5
Acreage for rice			
1. Early season	0.16	0.20	0.28
2. Customary	0.17	0.11	–
3. Late season	0.04	0.06	0.09
For barley	0.35	0.27	0.38
For wheat	0.13	0.23	0.18
For tobacco	0.19	0.19	0.16
For sweet potatoes	0.13	0.15	0.22
For vegetables	0.18	0.20	0.36
For forage crops	0.21	0.29	0.34
For other uses	0.05	0.06	–
Total acreage of land in crop	1.61 ha	1.71 ha	2.01 ha
Availability of land in per cent	264 %	271 %	291 %

1 *This farm is located at Sogisho, Ayagami-mura, Ayauta-gun, Kagawa Prefecture.*

4) Changes in crop plans through introduction of flexible rice growing with special reference to increase in production due to diversification in land use: The examples given in tables 5a and 5b from experimental station data may give an idea of how much profit can be obtained by increasing the efficiency of land use, although the actual costs have not been worked out. It is quite evident that the lands were actually converted to 3-crops-a-year patterns from 2-crops-a-year patterns by introducing the new method of rice culture. Several kinds of crops could be introduced in the crop plan among which the additional supply of forage crops would be most encouraging for dairy farmers. If sugar beet growing as a winter crop becomes possible, prospects will be much brighter as at present the whole sugar supply in Japan is entirely dependent on imported sources.

TABLE 5a

A comparison of production per ha. under different crop plans with or without the introduction of the new system during the period from October, 1954 to November 1955 at the Kagawa Agricultural Experiment Station.

Crop plan	Yield in metric tons per ha.									
	Small grains	Rice A	Rice B	Rice C	Seed soybean	Herbage Vetch	Herbage Soybean	Herbage Corn	Cushaw	Tobacco
1. S. g.-rice (customary)	4.95	5.61								
2. S. g.-herb soybean – C rice	3.97			5.92			22.5			
3. Vetch– B rice C rice			0.93	4.32		28.5				
4. Early s.g.-seed soybean–C rice	3.75			4.25	1.41					
5. Early s.g.-tobacco–C rice	3.55			4.29						63.3
6. Early s.g.-herbage soybean & corn–C rice	4.11			5.65			46.5	53.8		
7. Early s.g.-cushaw–C rice	3.52			4.29					25.1	

Legend: A rice = customary culture; B rice = Early season rice growing; C rice = Late season rice growing; S.G. = Small grain, either naked barley or wheat or both.

TABLE 5b

A similar comparison of production per ha. at the Oita Agricultural Experiment Station, during the period from October 1955 to November 1956.[1]

Crop plan	Yield in metric tons per ha.						
	Small grains	Rice A	Rice B	Rice C	Potatoes	Spinach	Red clover
1. S.g. (customary) – A rice (customary)	4.05	4.92					
2. Early S.g. – B rice – autumn potatoes	4.05		5.92		22.6		
3. Early S.g. – B rice – spinach	3.30		5.55			7.5	
4. Red clover – B rice – C rice			4.95	4.09			24.0

1 *See the legend in Table 5a.*

Conclusion

The practice of both early and late season rice growing is rapidly entering into the farm managment routine in south-western Japan. It has become possible to increase farm income either directly by including additional money crops such as tobacco, leguminous crops or vegetables or indirectly by raising more feed for cows thereby increasing the production of dairy goods. The outstanding reason for this rapid expansion of the new system is due to the quick recognition of the possibility of increasing rice yields by avoiding the risks due to typhoon damage as well as autumn decline. The farmers have also recognized that they could increase yields in shorter time spending comparatively less amounts for fertilizer. The traditional conception of a fixed rice growing season is no longer true. It is flexible if non-seasonal rice varieties are used with slight modifications in cultural practices, such as close planting, raising healthy seedlings, shallow planting etc. Fertilizer requirement will be only 80% of that used under the customary system.

Parathion spraying or dusting for the control of stem-borer can also be economized upon by reducing the number of applications by one or sometimes two because of a shift in the hatching period of the stem-borer in relation to the growth cycle of rice. The net result of the flexible rice culture brought about by the use of early maturing non-seasonal varieties is the intensification of land use bringing more profitable returns to the farmers.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

INTERNATIONAL RICE COMMISSION

SEVENTH SESSION

Saigon, Vietnam, 16-20 November, 1960

Provisional Agenda

1. Opening of session.
2. Election of officers.
3. Adoption of agenda.
4. Progress report by the Executive Secretary on the work of the Commission since its sixth session, including a financial statement regarding cooperative projects to which member nations have made special contributions.
5. Designation of Committees and assignment of any topics to be discussed initially in committee.
6. **Working Party on Rice Production and Protection:** consideration of the report of the eighth meeting of the reconstituted Working Party on Rice Production and Protection.
7. **Working Party on Rice Soils, Water and Fertilizer Practices:** consideration of the report of the seventh meeting of the reconstituted Working Party on Rice Soils, Water and Fertilizer Practices.
8. **Working Party on the Agricultural Engineering Aspects of Rice Production, Storage and Processing:** consideration of the report of the first meeting of the Working Party on the Agricultural Engineering Aspects of Rice Production, Storage and Processing.
9. Discussion of the possible relationship of the Commission with the International Rice Research Institute, the Philippines.
10. Discussion of long-term programs of the International Rice Commission.
11. Constitutional and procedural considerations and related matters.
12. Time and place of Next Session.
13. Adoption of the report.

MEETING OF THE WORKING PARTY ON AGRICULTURAL ENGINEERING ASPECTS OF RICE PRODUCTION, STORAGE AND PROCESSING

(INTERNATIONAL RICE COMMISSION)

Saigon, Vietnam, 10-15 November 1960

Provisional Agenda

1. Opening of the Meeting.
2. Election of Chairman.
3. Adoption of Agenda.
4. Progress report by a technical secretary on the past work of the Commission on rice production tools and machines and recent developments.
5. Reports from delegates on (a) selected machines and implements for rice production, and (b) simple water lifting devices for the irrigation of rice on small farms.
6. The establishment of a scheme for the exchange of selected implements and information between rice producing countries including financing for such a project.
7. Progress report by a technical secretary on the past work of the Commission on rice harvesting, storage and processing.
8. Reports from delegates on (a) pre-processing practices as harvesting, field curing, threshing, drying and storage, and (b) rice testing, processing and parboiling.
9. The conduct of trials on a regional basis with selected harvesting, processing and handling equipment.
10. Future plans for the Working Party.
11. Consideration of the report.
12. Adoption of the report with recommendations to the International Rice Commission.

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